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Success Story

SUCCESSFUL TEST REPRESENTS LEAP FORWARD FOR AIR FORCE TURBINE TESTING CAPABILITY

A team of researchers from the Propulsion Directorate at Wright-Patterson AFB, Ohio, completed the first true performance test of the uncooled high-pressure turbine for the F119 engine used in the F-22 air superiority fighter. The Air Force now has the ability to verify turbines designed for their warfighters.

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Accomplishment

Using the directorate's Turbine Research Facility (TRF) to make fifty runs, researchers applied the resulting data to create a complete operating map of the turbine. The researchers varied parameters, such as pressure ratio, Reynolds number, corrected speed, and temperature, in these runs.

The researchers acquired detailed surface pressure measurements and surface heat fluxes in these runs as well as overall aero performance data. This data, compared to design predictions, will help researchers analyze the F119 turbine performance by providing benchmark aero thermal data used to calibrate computational fluid dynamics (CFD) codes.

Background

Turbine failure in a jet engine is costly. Predicting performance of advanced turbine designs is difficult and expensive. Prediction depends on the quality of the predictive tools, which, in turn, depend on the quality of test data. For the F119 turbine test, the directorate research team solved a number of issues enabling them to generate exceptionally high quality test data. This project focused on the tip and shroud region of the turbine blades because only very limited experimental data in this region exists for a fully rotating rig.

The TRF can generate accurate torque measurements, remove the approach boundary layer flow prior to entering the test section, accurately control the corrected speed of the turbine, account for "g" field effects on pressure transducers, and eliminate oscillations in the flow field due to starting transients. Collectively, these capabilities provide safe, reliable, and highly accurate testing, which represents true performance testing for turbine stages. The Air Force now has the tools to fully understand the unsteady flow fields generated in turbine engines.

The highly accurate, high-frequency response pressure and heat flux measurements of the TRF now allow the technical community to better understand the physics of these complicated flow fields. Based on this improved understanding, researchers can calibrate CFD codes to higher accuracy and, hence, more accurate predictive capabilities. With more accurate predictive tools, researchers can create more durable and less costly turbines for future advanced engines while improving our understanding of currently installed engine performance.

Propulsion
Emerging Technologies

Additional information

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